AD-A235 403

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	AUG 1990	FINAL

4. TITLE AND SUBTITLE
Standardizing Submissions to the Major Automated Information System Review Council

5. FUNDING NUMBERS
C MDA903-85-C-0139

6. AUTHOR(S)
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Office of the Assistant Secretary of
Defense (Production and Logistics)
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Washington, D.C. 20301-8000

8. PERFORMING ORGANIZATION REPORT NUMBER
PL901R1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
A

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This paper examines the procedures the ASD(P&L) uses in preparing submissions to the MAISRC and identifies benefits, costs, and organizational interfaces as areas in which standardization may benefit P&L-sponsored submissions. Benefits as presented in MAISRC submissions tend to be understated, principally because systems are frequently justified on the basis of quantifiable, economic criteria. The many unquantifiable system benefits are more difficult to analyze and consequently are often understated. In preparing MAISRC submissions, P&L needs to ensure that the cost structure of the proposed information system is consistent with its capability. All capabilities should have corresponding cost categories. Analysts must identify those costs and tabulate them across the full system life cycle. P&L should encourage the use of parametric costing methods at an early stage to supplement analogy based procedures and to validate engineering estimates and vendor quotes. Particular emphasis should be placed on software life-cycle costing.

P&L should take the following steps to expedite the MAISRC process:

- Articulate system requirements precisely, and structure the proposed cost analysis to reflect those requirements.
- Clearly document the program costs and benefits, and indicate how each was measured.
- Communicate early and frequently with other organizations in the MAISRC process, such as PA&E and the office of the Director, Operational Test and Evaluation.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Information Systems; Cost-Benefit Analysis; Major Automated Information Systems Review Council (MAISRC)	46
	16. PRICE CODE

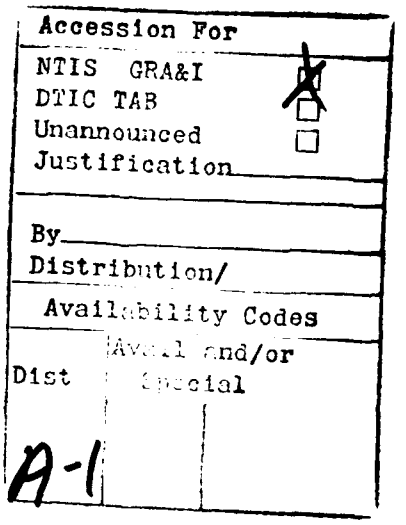
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCL	UNCL	UNCL	UL

STANDARDIZING SUBMISSIONS TO THE MAJOR AUTOMATED INFORMATION SYSTEM REVIEW COUNCIL

Report PL901R1

August 1990

Richard F. Shepherd



Prepared pursuant to Department of Defense Contract MDA903-85-C-0139.

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Executive Summary

STANDARDIZING SUBMISSIONS TO THE MAJOR AUTOMATED INFORMATION SYSTEM REVIEW COUNCIL

The Office of the Assistant Secretary of Defense for Production and Logistics (P&L) sponsors the development and implementation of automated Logistics information systems used by the Military Services and Defense agencies to satisfy their mission needs and to increase their management efficiency. If a system is large enough, P&L must submit documentation on it to the Major Automated Information System Review Council (MAISRC), which seeks to ensure that costs are reasonable and effective management is in place. The MAISRC requires rigorous cost and benefit analyses of the information system under review and of system alternatives. The analysis, documentation, and MAISRC approval process frequently delays system development.

We examined the procedures P&L uses in preparing submissions to the MAISRC and identified benefits, costs, and organizational interfaces as three broad areas in which standardization may benefit P&L-sponsored submissions. Benefits as presented in MAISRC submissions tend to be understated, principally because systems are frequently justified on the basis of quantifiable, economic criteria. The many unquantifiable system benefits are more difficult to analyze and consequently are often understated. Program managers must analyze those system benefits more closely, particularly in an environment of constrained funding or cost growth. They should also define operating baselines and implement standardized procedures to track both benefits and costs.

In preparing MAISRC submissions, P&L needs to ensure that the cost structure of the proposed information system is consistent with its capability. All capabilities should have corresponding cost categories. Analysts must identify those costs and tabulate them across the full system life cycle. P&L should encourage the use of parametric costing methods at an early stage to supplement analogy-based procedures and to validate engineering estimates and vendor quotes. Particular emphasis should be placed on software life-cycle costing. Consistency in presentation

format with guidance provided by the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation (PA&E) is desirable although as a practical matter such consistency may not be attainable.

Organizationally, P&L should take the following steps to expedite the MAISRC process:

- Articulate system requirements precisely, and structure the proposed cost analysis to reflect those requirements.
- Clearly document the program costs and benefits, and indicate how each was measured.
- Communicate early and frequently with other organizations in the MAISRC process, such as PA&E and the Office of the Director, Operational Test and Evaluation.

To address its long-term needs, P&L needs to create databases of historical costs for the automated information systems it sponsors to take advantage of state-of-the-art costing methods. Special problem areas for those systems, such as software development and maintenance, should be given first priority.

CONTENTS

CHAPTER 1

INTRODUCTION

DEFINITION AND PURPOSE

The Major Automated Information System Review Council (MAISRC) reviews the cost and management that the Office of the Assistant Secretary of Defense for Production and Logistics (P&L) proposes for the development and implementation of large automated information systems (AISs) for logistics. The MAISRC review process is extensive and has led to frequent delays in AIS development.

To expedite the MAISRC process, P&L needs to understand the factors that contribute to the delays. While all aspects of the MAISRC review process require comprehensive documentation, life-cycle cost estimates and cost-benefit analyses have historically warranted special scrutiny, and that scrutiny is frequently the major time-consuming activity. Since neither the services nor P&L have a standardized methodology to prepare cost and benefit estimates for AISs, reviews of cost analyses are conducted on a case-by-case basis.

In this report, we document the results of preliminary analyses of MAISRC materials and processes. These analyses are based primarily on information gathered in performing cost and benefits validation for two Air Force AISs [Weapons System Management Information System (WSMIS) and the Engineering Data Computer-Aided Retrieval System (EDCARS)], detailed discussions with analysts and managers who have prepared MAISRC submissions, and interviews conducted with other participants in the MAISRC process.

ORGANIZATION OF THE REPORT

This report describes our observations after reviewing MAISRC cost and benefit estimates. It also describes organizational concerns that should be addressed in preparing MAISRC submissions and outlines steps that will ensure satisfactory tracking of costs and benefits. The results of the analysis are presented in

Chapters 2, 3, and 4. Conclusions are provided in Chapter 5, along with recommendations to improve the efficiency of the MAISRC cost-benefit analysis process.

CHAPTER 2

ESTIMATING AUTOMATED INFORMATION SYSTEM COSTS

BACKGROUND

The preparation of cost estimates for MAISRC submissions is a time-consuming and laborious process. Frequently, DoD Components submitting MAISRC documentation devote several man-months of effort to preparing estimates in formats required internally, only to be compelled to repeat or revise the process in subsequent iterations as the submission is subjected to review at various levels.

While some of these problems are due primarily to differing organizational requirements, technical issues involved in AIS costing also contribute to the problem. Those technical issues can be segregated into three general categories:

- Identification of relevant cost elements
- Establishment of relationships between costs and cost-causative activities
- Selection of the most appropriate costing methodology.

In this chapter, we describe the key issues that MAISRC submissions should address in each of these categories and identify functional areas of AISs that have proven most difficult for the systems we examined.

IDENTIFYING RELEVANT COST ELEMENTS

The Office of the Assistant Secretary of Defense for Program Analysis and Evaluation (PA&E) has identified a range of cost elements that can be used as a guide in preparing MAISRC submissions. (We show those cost elements in Appendix A.) The PA&E guidelines are sufficiently broad to address general AIS structures and do not need amplification to be used as a point of departure for AIS analysis. However, they are merely guidelines, and hence they are not definitive for individual AISs. Each component submitting MAISRC materials tailors its efforts to the specific system under consideration. Consequently, any cost submission uses the

guidelines as an initial framework, but the final product reflects the characteristics of the specific AIS under consideration and the development phase of the system.

The PA&E guidelines[1] also suggest certain formats for the presentation of costs (and benefits) within this framework. These formats are designed to ensure logical consistency and completeness and to facilitate comparison between current and previous MAISRC submissions. (Examples of these formats are in Appendix B.)

ESTABLISHING COSTS AND COST-CAUSATIVE FACTORS

Establishing valid causal relationships between costs and cost-causative factors appears to be the principal difficulty encountered in preparing the cost-benefit analyses of AISs for the MAISRC. *Major problems in the MAISRC cost submissions frequently center on whether the proper and relevant costs have been estimated, rather than whether the costs have been estimated properly.*

There are two separate aspects to the problem of estimating costs by establishing causal relationships. First, for every function the AIS is projected to perform, some costs must be incurred somewhere. Second, all components of these costs need to be recognized over the life cycle of the AIS.

The first of these problem areas implies the need to reason through all of the inputs needed to produce a desired result, recalling the axiom, "You don't get something for nothing." Although the need for such thorough reasoning may appear obvious, it can readily be overlooked in AIS costing, particularly since requirements change over time and new system capabilities are added incrementally.

A major problem cited by PA&E is the failure to update functional descriptions after Milestone I. That failure in turn leads to unsubstantiated capabilities that are not supported by the original cost analysis. Costing problems of this nature can be alleviated by reevaluating and updating both functional descriptions and cost models periodically, ensuring consistency between the two.

While the failure to update functional descriptions over the AIS's life cycle is frequently symptomatic of an unstable, evolving requirement, a similar problem may also occur as additional potential users are identified. For example, EDCARS was

[1]"Department of Defense Automated Information System Life Cycle Cost and Benefits Estimation Guide (DoD Cost/Benefits Guide)," Office of the Assistant Secretary of Defense, Program Analysis and Evaluation, 30 May 1989.

projected to provide engineering data to assist users in retrieving information for bid set preparation, which it does. However, as additional functions became apparent for EDCARS, such as assistance in maintenance activities and supporting the newly created Office of Competition Advocacy, costs associated with those functions needed to be explicitly recognized.

The second problem area involves recognizing the costs that must be incurred to *maintain* a capability as well as those that must be incurred to provide that capability. In analyzing such costs, the analyst must ensure the following:

- All categories of costs have been considered.
- All the steps necessary to meet program objectives have been delineated.
- All phases of the system life cycle have been addressed.

Failure to recognize all costs frequently manifests itself in MAISRC submissions as an insufficient life-cycle cost estimate. Common errors include estimating costs only for a specific Program Objective Memorandum (POM) or budget cycle or truncating the analysis at the projected date of full operational capability (FOC). The AIS program standard life cycle includes a period of 10 years beyond FOC, and generally includes an overall system upgrade between 4 and 6 years after FOC to respond to anticipated advances in technology. By ending the analysis prematurely, the analyst does not consider the full range of operating and support costs, system upgrades to prevent obsolescence, or preplanned product improvements.

SELECTING APPROPRIATE COSTING METHODS

In selecting a methodology for estimating AIS costs, the analyst is constrained by three key factors:

- The milestone for which the analysis is being prepared
- Available data
- The resolution required in the estimate.

Within the general cost structure presented in Appendix A, the analyst has wide latitude to select acceptable costing tools and techniques. Techniques may include analogy-based estimates, standard engineering estimates and vendor quotes, and parametric cost estimating relationships.

Analogy-based estimates are most appropriate for the early milestones and in circumstances in which historical databases are not available to use in projecting empirical relationships. These estimates involve expert judgments and experience to gauge the degree of similarity between the elements of a proposed system and known costs of previous systems. They also require judgment to assess how any dissimilarities should affect the ultimate cost estimate. As the system progresses toward later milestones, analogy-based estimates should gradually be replaced by firmer estimates derived from engineering estimates.

Engineering estimates are built up from component cost estimates when the components that most strongly affect significant cost elements are reasonably well known. Such estimates may be provided from build-ups of hardware costs from standard sources such as Datapro, or from quotes solicited directly from hardware and software vendors. The estimates and vendor quotes are then supplemented by assessments of required labor hours at known labor rates. Alternatively, cost estimation packages are commercially available, but they require that input data be specified by the cost analyst. MAISRC submissions should increasingly rely on engineering estimates as they progress to the later milestones since such estimates provide greater resolution as the program becomes better defined.

Parametric cost estimating relationships (CERs) can provide greater accuracy than analogy-based estimates in the early stages of a program even though parametric models require an historical database for development and calibration. By using parametric CERs, the analyst can identify prominent cost "drivers" early in the estimating process and is better able to assess the sensitivity of the estimate to key parameters and to analyze the impact of uncertainty on the cost estimate.

Parametric modeling is currently used widely in software cost estimating. Of the systems we examined, software development cost was reported to be the single most difficult cost element to estimate. Although software costs were invariably estimated using commercially available, reputable models, input parameters developed for the models led to considerable disagreement. Consequently, estimates for software development costs ranged from $8 to $150 per line of code.

Such disparate estimates illustrate the state of the art in software cost estimation. From the perspective of the MAISRC, the use of parametric models to estimate software costs greatly enhanced the productivity of the process. By enabling

the participants in the process to focus their discussion on differences of opinion in key input variables driving the cost estimate, parametric models narrowed discussion to a manageable level.

CHAPTER 3

DETERMINING AUTOMATED INFORMATION SYSTEM BENEFITS

ANALYSIS OF BENEFITS

The *DoD Cost/Benefits Guide*[1] prepared by OASD(PA&E) suggests methods to identify benefits, measure quantifiable benefits, and evaluate nonquantifiable benefits. The methods are presented in a level of detail similar to the guidelines provided for cost analysis: broad guidance with wide latitude for analysts to select specific techniques appropriate to their particular circumstances.

As part of the guidance, the *DoD Cost/Benefits Guide* defines "quantifiable" and "nonquantifiable" to assist cost analysts in discriminating among costs. A quantifiable benefit is any advantage provided by the AIS that can be valued in monetary terms or equivalents, such as labor. Conversely, nonquantifiable benefits are defined as favorable results of using an AIS that cannot, by nature, be valued in monetary terms. The analyses we reviewed generally categorized benefits as quantifiable and nonquantifiable, although the level of supporting documentation varied widely.

Irrespective of how AIS benefits were structured, we found two major recurring problems with the analysis of benefits. First, the definition of the program baseline is usually inadequate and that inadequacy complicates the analysis of improvements brought about by implementing the information system. Second, insufficient procedures are available to determine whether the benefits are obtained once the system has achieved initial or full operational capability. These problems overshadowed the purely technical issues surrounding identification and estimation of AIS benefits.

The remainder of this chapter addresses areas that should be considered in benefits analysis and then discusses the impact that improved documentation and tracking systems may have on MAISRC analyses.

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[1]Ibid.

IDENTIFYING QUANTIFIABLE BENEFITS

Quantifiable benefits are those that either reduce costs or enhance value. Cost-reduction benefits result from an improvement to existing operations, while value enhancement benefits provide additional capability for an organization. The OASD(PA&E) *DoD Cost/Benefits Guide* discusses ways to measure cost-reduction benefits and provides general comments on determining measurable quantities in an AIS benefits evaluation. However, it does not offer any guidance for measuring the value of new or enhanced capabilities.

To identify the benefits that can be measured, the analyst must recognize operations that replace those of the baseline system. Replacing a particular task, function, or piece of equipment is a common benefit that can readily be converted into dollars. Replacement operations provide substantial value to the quantifiable benefits total although, again, no standardized methods for quantifying such benefits are available. Finally, cost avoidance is an area that can be quantified by forecasting the increased workload that will be avoided with the implementation of the AIS.

IDENTIFYING NONQUANTIFIABLE BENEFITS

Identifying and evaluating nonquantifiable benefits offers the greatest challenge – and is perhaps the single most productive area for analytical improvement – in the MAISRC costing process. Theories abound on how best to evaluate nonquantifiable benefits. None is applicable in all circumstances, and virtually all have some flaws. The *DoD Cost/Benefits Guide* suggests a few worthwhile techniques, although several others are acceptable. The guide suggests benefits be categorized and then compared with benefits of alternative AISs. The guide acknowledges that, at times, a narrative description of the characteristics of the nonquantifiable benefits may be the best that the analyst can provide. The following are examples of nonquantifiable benefits:

- Improved decision making
- Better management information
- Greater versatility or flexibility
- Better presentation of information
- Improved timeliness of information

- Improved staff morale
- Fulfillment of operating requirements.

We suggest additional types of intangible benefits that are directly applicable to DoD organizations. They include credibility and prestige; information integrity, flexibility and accessibility; staff training in new technologies; support of the planning, programming, and budgeting process; and better relations with other Government organizations.

The PA&E guide proposes several methods for measuring nonquantifiable benefits, ranging from a simple enumeration of the benefits to a cardinal or ordinal ranking of them. Other evaluation methods, including multiattribute decision theory and the analytical hierarchy process, are appropriate for including the judgments of more than one individual.

Numerous other analytical techniques such as the following may be used to supplement the analysis of nonquantifiable benefits:

- Delphi technique
- Incremental analysis
- Value analysis
- Excess tangible cost
- Worst case/most likely case/best case methods
- Checklists
- Critical success factors
- Cost-value analysis.

Information on these methods is given in the documents cited in the bibliography.

THE ROLE OF BASELINE DOCUMENTATION IN IMPROVING ESTIMATES

Regardless of the nature of the proposed AIS, the first step in preparing cost and benefit estimates is to document the baseline system and/or procedures that the proposed AIS will replace. Providing adequate documentation of the program

baseline is usually laborious, but it is critical to the effective measurement of AIS benefits.

For the AISs we examined, program baseline documentation was based on point estimates derived from snapshots of current operations or from extrapolations of limited survey data. In some cases, the data were as much as 15 years old. Although the program manager needs to expend resources judiciously, investing in quality baseline documentation early in the development process can provide substantial returns later in the system life cycle.

Problems resulting from poorly documented program baselines are exacerbated when the system requirements evolve. For example, in analyzing EDCARS, we found that the system provided a substantial number of benefits that were not anticipated in the original system concept. Its principal benefits were that it increased competitive procurements. However, no data were (or are) available to measure the value of all the components of that benefit, such as reductions in contracting administrative lead-time and reductions in the cost of reprocuring lost or missing engineering data. Moreover, as the EDCARS hardware and software became available, additional users found applications for the EDCARS data, and additional benefits were identified. Because the program baseline was not fully documented, the benefits cannot be quantified, and "re-creation" of the baseline operating environment is proving to be difficult and expensive.

This problem is even more pronounced if the functional specifications of the system change over time: rebaselining a program to reflect new functions is rare.

A thorough evaluation of the program baseline is also valuable in case some of the originally expected benefits do not materialize. To the extent that tangible and quantifiable benefits frequently drive AIS requirements, AISs are easier to justify on tangible economic grounds. And since quantifiable benefits are given prominence in the cost-benefit analyses, a well-documented program baseline can maintain the continued viability of a program over time by providing a solid basis for establishing cost savings and by broadening the base upon which program benefits are justified. These characteristics become increasingly important to maintaining program continuity if program costs increase beyond expectations, if key benefits are smaller than expected, or if budget reductions force agency-wide cutbacks.

For example, in the benefit/cost analysis of WSMIS, nearly all projected benefits were intangible and could not be quantified. Of those that were tangible, data did not exist to yield quantifiable estimates for all but one benefit. For that one remaining benefit, the estimate in the economic analysis was projected to be a "maximum benefit," with a smaller value possible. Since no procedures were established to track the attainment of benefits, the economic benefit realized by WSMIS may in fact be substantially less than originally projected.

Users of WSMIS report that it has substantially increased their capabilities. That these capabilities provide intangible benefits does not diminish their value. However, intangible benefits may not be as prominent in other MAISRC-level AISs. Therefore, there is a need to evaluate tangible benefits as thoroughly as possible.

When systems are justified on the basis of quantifiable economic criteria, AIS program managers need to analyze program baselines thoroughly to ensure that benefits as presented in MAISRC submissions are not understated. At the same time, they should not deemphasize unquantifiable system benefits simply because economic criteria are sufficient to show a positive net present value.

AIS program managers need to analyze system benefits more closely, particularly in an environment of constrained funding or cost growth. Operating baselines must be well defined, and adequate procedures need to be implemented to track both benefits and costs.

CHAPTER 4

ORGANIZATIONAL ISSUES

COORDINATION WITH OTHER ORGANIZATIONS

While the analysis of costs and benefits is vitally important to the successful preparation of a MAISRC submission, each such submission requires that OASD(P&L) interact with numerous other OSD organizations. During our study, we found that sensitivity to those interactions had, at times, been as important to the submitting organization as the technical issues surrounding cost analysis.

Two OSD organizations – OASD(PA&E) and the Office of the Director, Operational Test and Evaluation (ODOT&E) – figured prominently during the course of our analysis of MAISRC submissions. In fulfilling their assigned responsibilities, each can significantly affect P&L MAISRC submissions. First, P&L needs to ensure early and continual coordination with PA&E. That coordination is critical to the success of the MAISRC process. Second, P&L needs to design MAISRC submissions to meet the ongoing requirements of DOT&E for comprehensive test and evaluation. By understanding the requirements and perspectives of these organizations, P&L can structure MAISRC presentations and procedures for maximum effectiveness.

PA&E PERSPECTIVE

PA&E contends that cost and benefit submissions to the MAISRC should provide two key elements: adequate program definition and adequate documentation. If the MAISRC submission contains these elements, P&L and PA&E will have a common basis for agreement on cost and benefit estimates. By addressing these concerns early in the MAISRC process, P&L can minimize the delay caused by PA&E review.

Program Definition

The PA&E role in preparation of submissions to MAISRC is to validate cost and benefit estimates; MAISRC does not require it to prepare an independent cost

estimate (ICE). PA&E does not merely review the submission; it attempts to understand and validate the analysis. The Comptroller has provided instructions Department of Defense Instruction [(DoDI) 7041.3, Economic Analysis and Program Evaluation for Resource Management, and DoDI 7920.2, Automated Information System (AIS) Life-Cycle Management and Milestone Approval Procedures] on how to conduct economic analyses. These regulations serve as guidelines for the Services in preparing economic analyses for MAISRC submissions, and they provide recommended lead-times to ensure timely review.

In validating the estimates, PA&E must first understand the requirement the Service is trying to fulfill. To do so it consults the program office for a definition of its mission. It then subdivides the mission into functional areas and maps the status quo system into those functional areas.

Having defined the status quo, PA&E then defines the "program" by stating the objectives of the program, how those objectives relate to the mission, and how the program will affect the status quo. PA&E is particularly concerned with specifying which activities are classified as maintenance of the old system and which are classified as improvements to the old system. As a final step, PA&E verifies that the Services have defined a realistic schedule for meeting the program objectives.

By performing these actions – defining the status quo, defining the program, and verifying the realism of the program schedule – before PA&E does, P&L can effectively design a program to develop and implement an AIS. The MAISRC submission can then readily be derived from this design.

Program Documentation

The principal problem with MAISRC submissions, as reported by PA&E, is documentation. PA&E will not permit a MAISRC submission to go forward until the documentation is in order. Fundamentally, good documentation requires a well-conceived plan for meeting the program objectives, in as much detail as possible. In its validation role, PA&E places a strong emphasis on both logic and believability in AIS estimates. Documentation plays a key role in meeting these criteria.

Good documentation invariably accelerates the MAISRC review process. Although PA&E may not agree with the Service's estimate, clear documentation of the estimate at least provides a well-defined basis for discussion. Preferably, such

documentation should be provided to PA&E as early in the process as possible. By submitting a "straw man" cost estimate early, the Services provide the opportunity for early clarification and correction, thereby facilitating MAISRC approval.

DOT&E PERSPECTIVE

Submissions to the MAISRC must include plans for testing that is sufficient to demonstrate the efficacy of the system. The plans are reviewed by DOT&E, and two essential elements of that review are assessments of the sponsor's test and evaluation master plan (TEMP) and the operational test plan. Organizations sponsoring MAISRC submissions need to devote careful attention to test plans in general and to the TEMP in particular.

At Milestone I, DOT&E's principal concern is to verify that the System Concept Paper (SCP) adequately addresses testing. In particular, it is concerned about the TEMP, which needs to be included in MAISRC submissions beginning with the earliest milestones. The TEMP is divided into five parts:

- System Description – This section defines the risks involved in developing the AIS and delineates how the proposed tests will diminish those risks.
- Management – This section describes who will manage the program and where and when the testing will be accomplished. More important, it describes who the independent testers will be and who the "non-independent" testers will be. This particular aspect is critical to DOT&E because it needs to ascertain that the test team is independent of the program management.
- Tests – This section describes the tests that will be performed on the system by people reporting to the program manager. Descriptions of the tests need to be specific.
- Independent Test Plan – This section describes the testing that will be done by someone other than the program manager (usually a peer or higher independent authority).
- Resources – This section describes the time, money, and personnel necessary to conduct testing. Explicit recognition of resource costs is desired since test costs are frequently embedded in other elements of the MAISRC submission. DOT&E will ensure that cost estimates are consistent with the time estimates, and that both are reasonable compared to previous experience. Deviations need to be explained.

Major Issues Concerning the Content of the TEMP

From the DOT&E perspective, the principal difficulties in gaining MAISRC approval arise from the Independent Test Plan section of the TEMP. For example, the Services need to define "operational tests" adequately and determine what the "critical issues" are. These issues need to be resolved in concert with the user community, which frequently has not adequately considered them prior to Milestone I. Consequently, if P&L proposes imprecise tests that may not validate the utility of the system, then DOT&E will reject the MAISRC submission.

Another problem arises from determining how long the tests should run. DOT&E recommends they run at least a month, but shorter or longer periods can be justified in the TEMP if they are shown to be reasonable. The objective of the tests should be to demonstrate system capability under a variety of actual operating conditions. To the maximum extent possible, P&L needs to anticipate the full range of expected conditions and plan tests accordingly.

DOT&E recommends that actual data be used in the tests, but if the full range of conditions is not expected during the test window (e.g., heavy end-of-year processing), then conditions for the test may be simulated. The General Accounting Office, in particular, has expressed concern that systems be operational during periods of stress, such as would occur in wartime. If the test is simulated, then for test purposes, such stress conditions should also be simulated.

Development tests on system components are acceptable substitutes for operational tests. DOT&E encourages development tests because of congressional concern over the level of system implementation required to carry out operational tests. For large systems, operational tests can be expensive, and any shortcomings detected during those tests are more expensive to correct than they would be if detected during earlier development testing. P&L should therefore consider including development tests in lieu of operational tests in their MAISRC submissions.

Other Issues in DOT&E's Review of MAISRC Submissions

DOT&E looks for four major characteristics in its evaluation of MAISRC submissions: test team independence, adequate resources for testing, robustness of the testing, and training.

The independence of the "independent" test team is especially problematic for smaller agencies, such as The Defense Logistics Agency (DLA), where the proposed independent testers may actually have a close (or subordinate) relationship to the program manager. MAISRC submissions need to clearly state how independence will be achieved.

DOT&E is also very concerned that the resources allocated for testing are adequate. Frequently, MAISRC rejects submissions because neither enough time nor enough funding is allotted to testing.

The Program Office also needs to design the TEMP to ensure that enough of the system will be tested to yield justifiable results. "Justifiable results" implies that the tests should accommodate a variety of operating conditions. Of particular interest to DOT&E is the discussion of what will not be tested and what cannot be tested. The TEMP should discuss the effect of any omissions on the independent tests (Part 4) and on the program manager's knowledge. The increased risks should be delineated, and the TEMP should describe the actions the program manager intends to take to mitigate those risks.

Finally, the TEMP needs to address training. Training has been characterized by DOT&E as the biggest single impediment to system utilization. P&L's MAISRC submissions should therefore provide sufficient training plans to enhance the effectiveness of the AIS. Documentation of these training plans in the MAISRC submission will increase the likelihood of MAISRC approval.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Standardizing the development and content of OASD(P&L) submissions to the MAISRC can reduce delays in AIS development. Areas that can benefit most from standardization include: benefits analysis, cost analysis, and organizational interfaces. Tangible, quantifiable AIS benefits generally provide the economic justification for an investment while intangible AIS benefits, which can also be substantial, provide additional program justification in an environment of cost growth or constrained funding. P&L should increase its emphasis on documenting intangible AIS benefits and examine innovative techniques for assessing the value of such benefits.

For an accurate estimation and analysis of benefits and costs, P&L must clearly identify the program baseline. Failure to document the program baseline adequately makes cost estimates questionable and severely hampers the validation of benefits after the system is implemented. Changes in functional requirements or the addition of new users to the system can only be evaluated against a thoroughly documented baseline. P&L should devote additional effort to ensuring adequate baseline documentation.

With respect to costs, P&L needs to ensure that the proposed cost structure is consistent with the capability being proposed. All capabilities should have corresponding costs, and those costs should be tabulated across the full system life cycle. P&L should precisely articulate system requirements and structure the proposed cost analysis to reflect these requirements. P&L needs to clearly document the program costs and benefits and indicate how each was measured.

P&L should encourage the use of parametric costing methods at an early stage to supplement analogy-based procedures and to validate engineering estimates and vendor quotes. As a first step in developing appropriate parametric cost estimating tools, P&L should create a database of historical costs of P&L-sponsored AISs. Special problem areas for P&L-sponsored AISs, such as software development and maintenance, should be given first priority.

Organizationally, P&L can take several steps to expedite the MAISRC approval process. Early and frequent communications with other organizations in the MAISRC process – PA&E and DOT&E are two – are essential. Consistency in presentation format with PA&E guidance is desirable although as a practical matter such consistency may not be attainable.

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APPENDIX A

PA&E LIFE-CYCLE COST ELEMENTS

PA&E LIFE-CYCLE COST ELEMENTS

	PA&E guidelines
1.0	**RDT&E**
1.01	Program planning and management
1.02	Development hardware
1.03	Development software
1.04	Development document/data
1.05	Development training
1.06	Development system test and evaluation
1.07	Development logistics support
1.08	Development facility modification/construction
1.09	Other development
2.0	**INVESTMENT**
2.01	Hardware
2.011	Processing units
2.0111	Central processing units
2.0112	Intermediate processing units
2.0113	Terminal processing units
2.012	Peripheral devices
2.0121	Printers
2.0122	Storage devices
2.0123	Other
2.013	Communications hardware
2.0131	Wide-area gateways (Broadband)
2.0132	Wide-area networks
2.0133	Modems
2.0134	Local area network (LAN)
2.0135	Crypto
2.0136	Other communications hardware
2.014	Other hardware

Source: "Department of Defense Automated Information System Life Cycle Cost and Benefits Estimation Guide (DoD Cost/Benefits Guide)," Office of the Assistant Secretary of Defense, Program Analysis and Evaluation, 30 May 1989.

PA&E LIFE-CYCLE COST ELEMENTS (cont.)

	PA&E guidelines
2.02	**Software**
2.021	Commercial off-the-shelf (COTS)
2.0211	Operating system software
2.0212	General administrative software
2.022	Mission-specific application software
2.0221	Contractor-developed software
2.0222	Organically developed software
2.023	Communications software
2.0231	Wide-area gateways (Broadband)
2.0232	Wide-area networks
2.0233	Modems
2.0234	Local area networks
2.0235	Crypto software
2.0236	Other software
2.04	**Systems integration, testing, and evaluation**
2.05	**Program management**
2.06	**Training**
2.07	**Support equipment**
2.08	**Initial spares**
2.09	**Initial cataloging**
2.10	**Initial data requirements**
2.11	**Site activation**
2.12	**Industrial facilities**
2.13	**Warranties**
2.14	**Initial supplies**
2.15	**Engineering changes**

Source: "Department of Defense Automated Information System Life Cycle Cost and Benefits Estimation Guide (DoD Cost/Benefits Guide)," Office of the Assistant Secretary of Defense, Program Analysis and Evaluation, 30 May 1989.

PA&E LIFE-CYCLE COST ELEMENTS (cont.)

	PA&E guidelines
2.16	Preplanned product improvements
2.161	Hardware preplanned product improvements
2.162	Software preplanned product improvements
2.17	Upgrades
2.18	Offices and general support furniture
3.0	**OPERATING AND SUPPORT**
3.01	System/material/item management
3.011	System management
3.012	Operating personnel
3.014	Training
3.02	Unit/base operations
3.03	Hardware maintenance support
3.031	Depot level
3.032	Field level
3.04	**Second destination transportation**
3.05	**Environmental and hazardous material storage and handling**
3.06	**Contract leasing**
3.07	**Operations investment**
3.071	Replenishment spares
3.072	Fuel and petroleum, oil, and lubricants (POL)
3.073	Replenishable supplies and consumables
3.08	**Software maintenance**
3.081	Central maintenance and repair, software
3.082	Field operation maintenance, software
3.09	Parallel system operation
4.0	**DISPOSAL**

Source: "Department of Defense Automated Information System Life Cycle Cost and Benefits Estimation Guide (DoD Cost/Benefits Guide)," Office of the Assistant Secretary of Defense, Program Analysis and Evaluation, 30 May 1989.

APPENDIX B

COST AND BENEFIT ANALYSIS
OASD(PA&E)-RECOMMENDED FORMATS

COST AND BENEFIT ANALYSIS
OASD(PA&E)-RECOMMENDED FORMATS

FORMAT A

COMPARISON WITH PREVIOUS ESTIMATE

(FY___ $ in millions)
(Total program or alternative)

Element no.[a]	Cost element title	Current est. date	Previous est. date	Delta	Note
1.0	RDT&E	XX	XX	X	b
1.01	Program planning and management				
1.02	Development hardware				
2.0	Investment	XX	XX	X	b
2.01	Hardware				
2.02	Software				
3.0	Operating and support	XX	XX		
3.01	System/material/item management				
3.02	Unit/base operations				

Note: OASD(PA&E) = Office of the Assistant Secretary of Defense (Program Analysis and Evaluation); RDT&E = research, development, test and evaluation.

[a]Reference Appendix A.

[b]Explanation of delta.

FORMAT B

PRIOR YEAR COSTS

(FY___ $ in millions)
(Total program or alternative)

Element no.[a]	Cost element title	FY	Total
1.0	RDT&E	FY-N, FY-4, FY-3, FY-2, FY-1	
1.01	Program planning and management		
1.02	Development hardware		
2.0	Investment		
2.01	Hardware		
2.02	Software		
3.0	Operating and support		
3.01	System/material/item management		
3.02	Unit/base operations		
Totals			

[a]Reference Appendix A.

Program start date_____

Program completion date_____

Date of pending MAISRC review _____

Instruction: Display cost from the first year of program inception to current fiscal year for each alternative or the total program as appropriate. Where possible use the same cost element structure as Format A.

FORMAT C

LIFE-CYCLE COST ESTIMATE

(FY___ $ in millions)
(Total program or alternative)

Element no.[a]	Cost element title	Prior years FYXX to FYXX	FYXX	FY-n	Total
1.0	RDT&E				
1.01	Program planning and management				
1.02	Development hardware				
2.0	Investment				
2.01	Hardware				
2.02	Software				
3.0	Operating/support				
3.01	System/material/item management				
3.02	Unit/base operations				
Totals					

[a]Reference Appendix A.

Instructions:
1. Notes will be numbered to correspond with element numbers.
2. Cover 10 years after year of full operational capability.
3. Cover upgrade caused by wearing out and obsolescence.
4. Include prior year in total.

FORMAT D

PM AND ICE COMPARISON

(FY___ $ in millions)
(Total program or alternative)

Element no.[a]	Cost element title	PM estimate	ICE estimate	Delta	% Delta
1.0	RDT&E				
1.01	Program planning and management				
1.02	Development hardware				
2.0	Investment				
2.01	Hardware				
2.02	Software				
3.0	Operating and support				
3.01	System/material/item management				
3.02	Unit/base operations				
Totals					

Note: PM = program manager; ICE = independent cost estimate.

[a]Reference Appendix A.

FORMAT E

PROGRAM REQUIREMENTS & POM OR BUDGET COMPARISON

(Then-year $ in millions)

	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX
Requirement						
R&D						
Investment						
O&S						
Total						
Last POM or budget submission as appropriate[a]						
R&D						
Investment						
O&S						
Total						
Excess/(Shortfall)						
R&D						
Investment						
O&S						
Total						

Note: POM = Program Objective Memorandum; O&S = operations and support.

[a]Identify document.

FORMAT F

COMPARISON OF ALTERNATIVE WITH STATUS QUO

(FY___ $ in millions)
Alternative title:

Element no.[a]	Cost element title	Current FYXX		FYXX		FY-N		Total	
		Alt.[b]	SQ[c]	Alt.[b]	SQ[c]	Alt.[b]	SQ[c]	Alt.[b]	SQ[c]
1.0	RDT&E								
1.01	Program planning and management								
1.02	Development hardware								
2.0	Investment								
2.01	Hardware								
2.02	Software								
3.0	Operating and support								
3.01	System/material/item management								
3.02	Unit/base operations								
Totals									

[a]Reference Appendix A.

[b]For the alternative (Alt.) named in the format title.

[c]Cost for the status quo (SQ) alternative.

FORMAT G

COMPARISON WITH PREVIOUS QUANTIFIABLE BENEFIT ESTIMATE

(FY___ $ in millions)
(Total program or alternative)

Element no.[a]	Cost element title	Current est. date	Previous est. date	Delta	Note
1.0	RDT&E	XX	XX	X	1
1.01	Program planning and management				
1.02	Development hardware				
2.0	Investment	XX	XX	X	2
2.01	Hardware	XX	XX	X	3
2.02	Software				
3.0	Operating and support	XX	XX	X	4
3.01	System/material/item management				
3.02	Unit/base operations				
Totals					

[a]Reference Appendix A.

FORMAT H

QUANTIFIABLE BENEFIT ESTIMATE

(FY___ $ in millions)
(Total program or alternative)

Element no.[a]	Cost element title	Prior year FYXX to FYXX	FYXX	FY-n	Total
1.0	RDT&E				
1.01	Program planning and management				
1.02	Development hardware				
2.0	Investment				
2.01	Hardware				
2.02	Software				
3.0	Operating/support				
3.01	System/material/item management				
3.02	Unit/base operations				
Totals					

[a]Reference Appendix A.

Instructions: 1. Explanatory notes, if needed, will be numbered to correspond with element numbers.

2. Cover 10 years after year of full operational capability.

3. Cover upgrade caused by wearing out and obsolescence.